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(54) Pollution and ignition control in an internal combustion engine

(57) Additional fluid, eg atmospheric or pressurised air, fuel or air-fuel mixture, is admitted to the combustion chamber via a valve-controlled inlet associated with an ignition promoting device ie spark plug 26, injection nozzle 68 or heater plug 78. Fluid may be supplied via a unit from duct 63 through an annular flutter valve 41 into chamber 44 below spark plug electrode 47, grooves in the base of housing 43 preventing the valve from sticking open.

– Rien à voir avec notre invention !!
(optimisation de l'allumage ici !!)

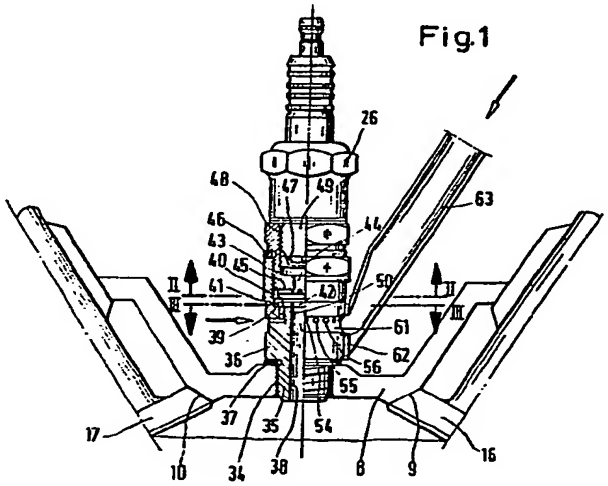

Fig.1

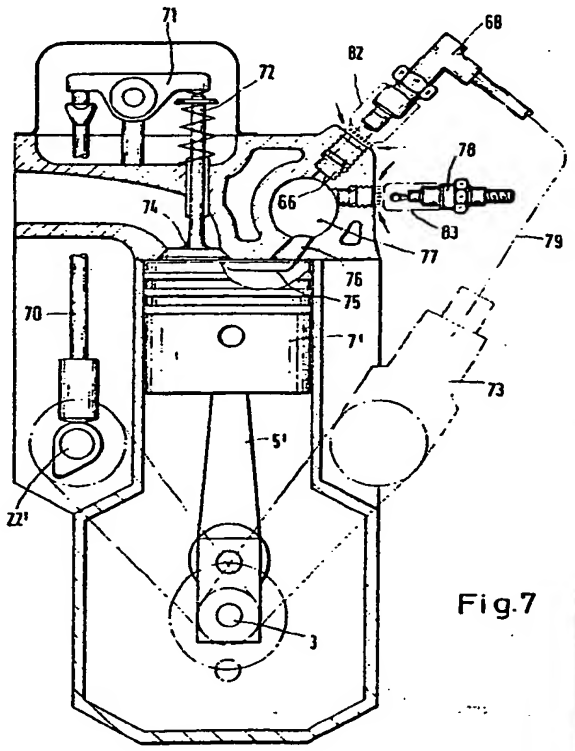

Fig.7

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Fig.1

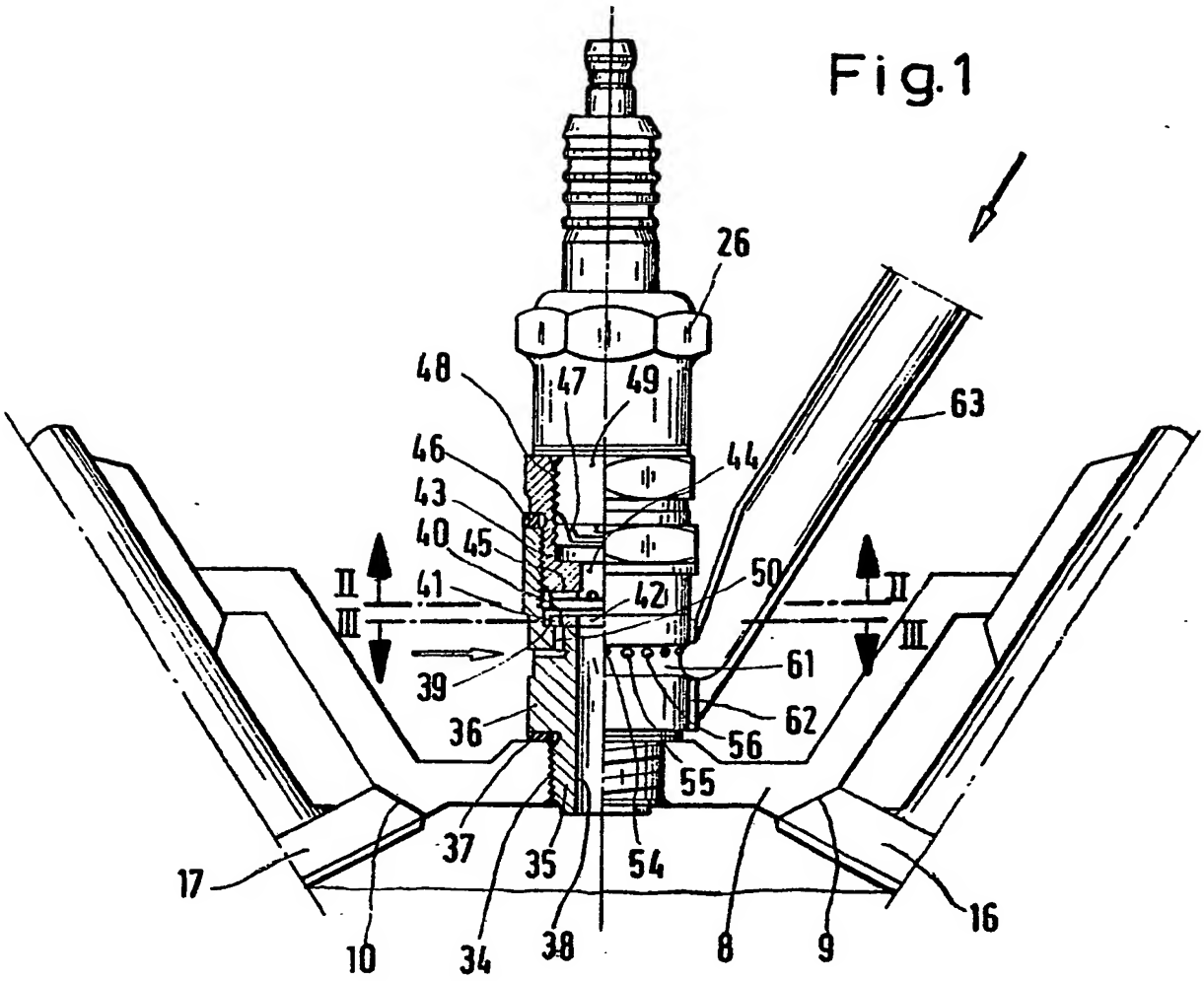


Fig.2

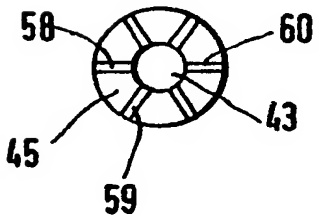
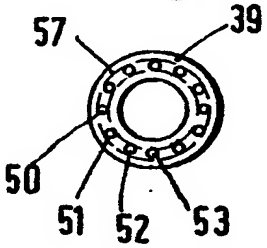


Fig.3



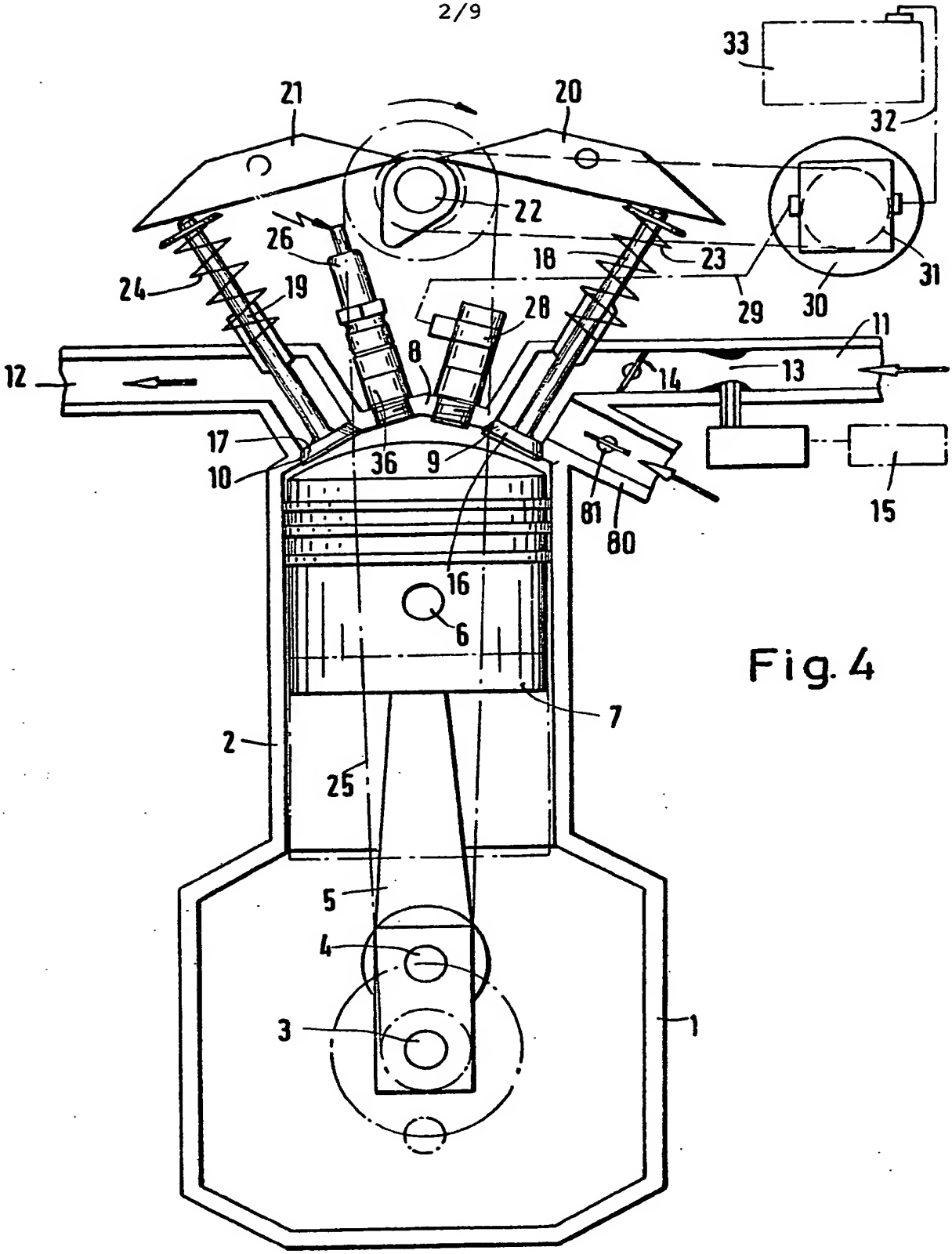


Fig. 4

Fig.5

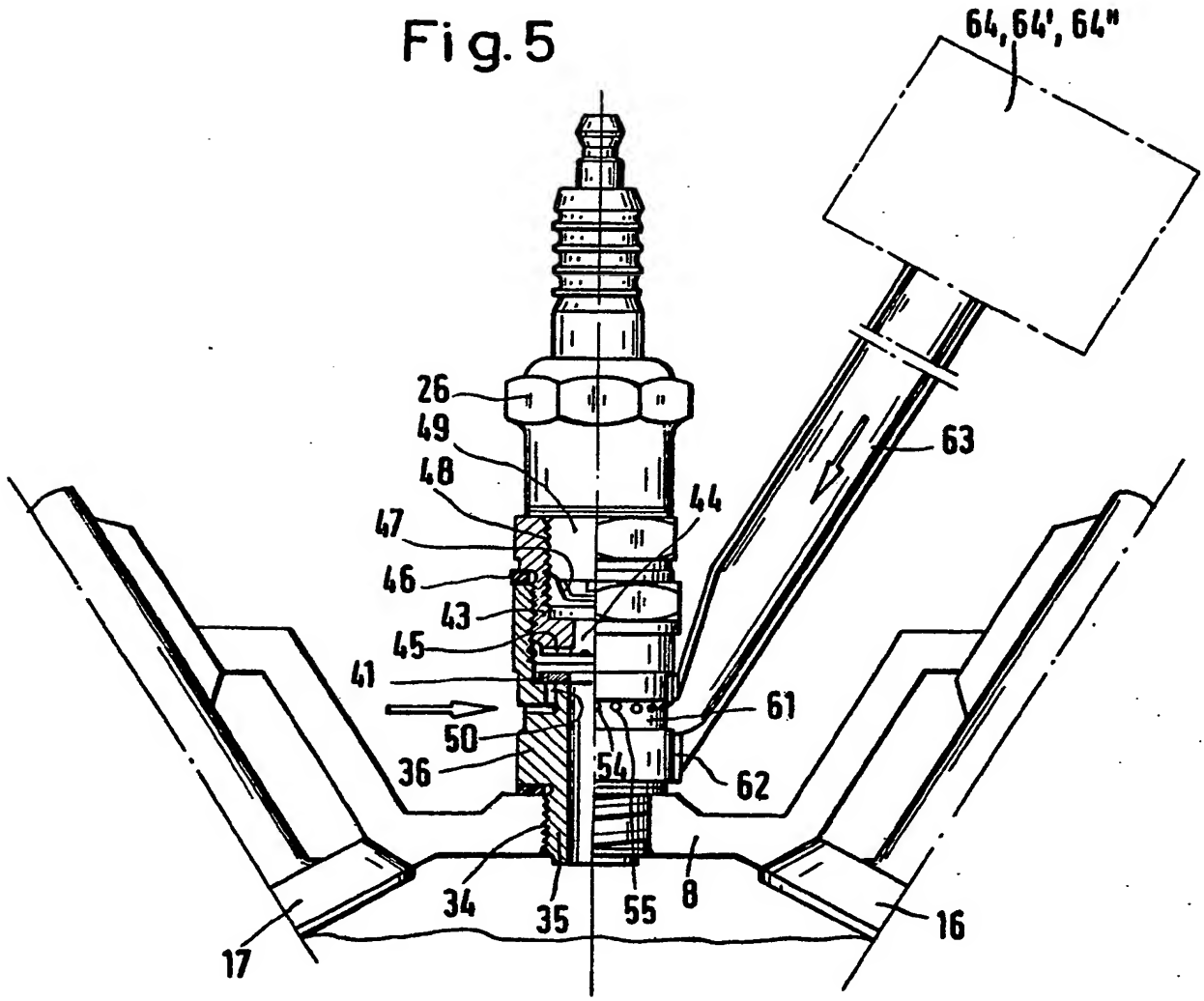
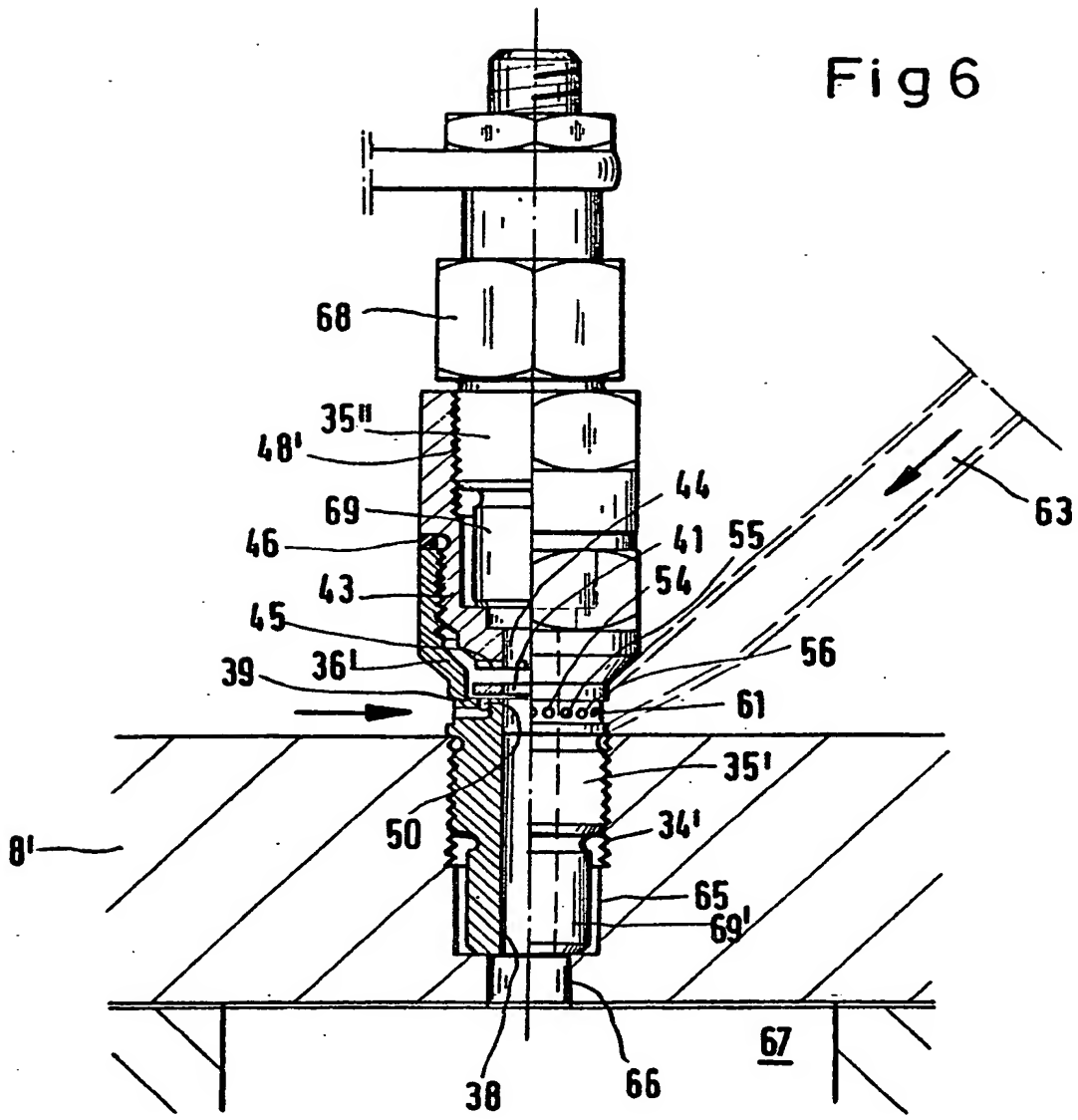


Fig 6



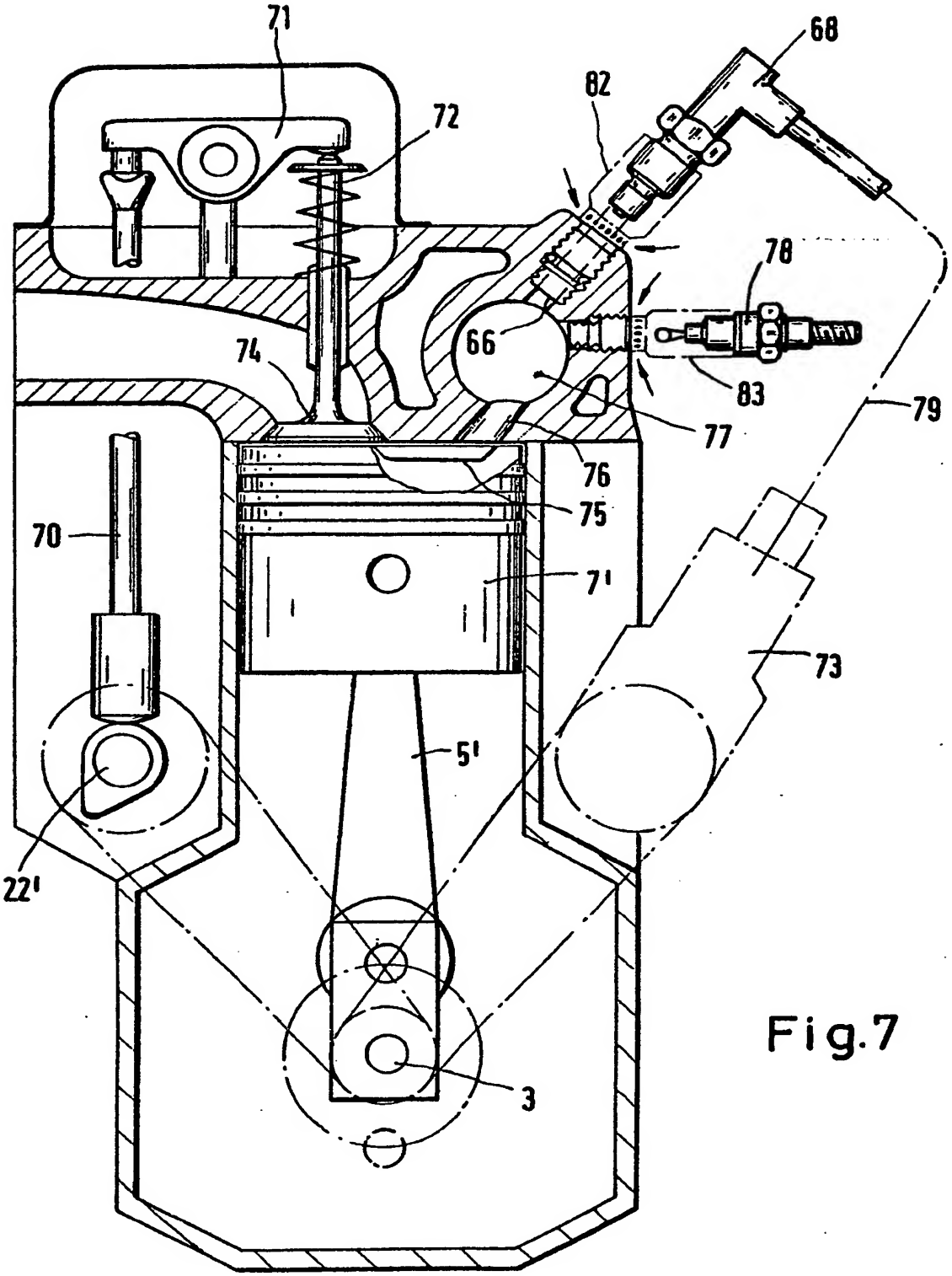
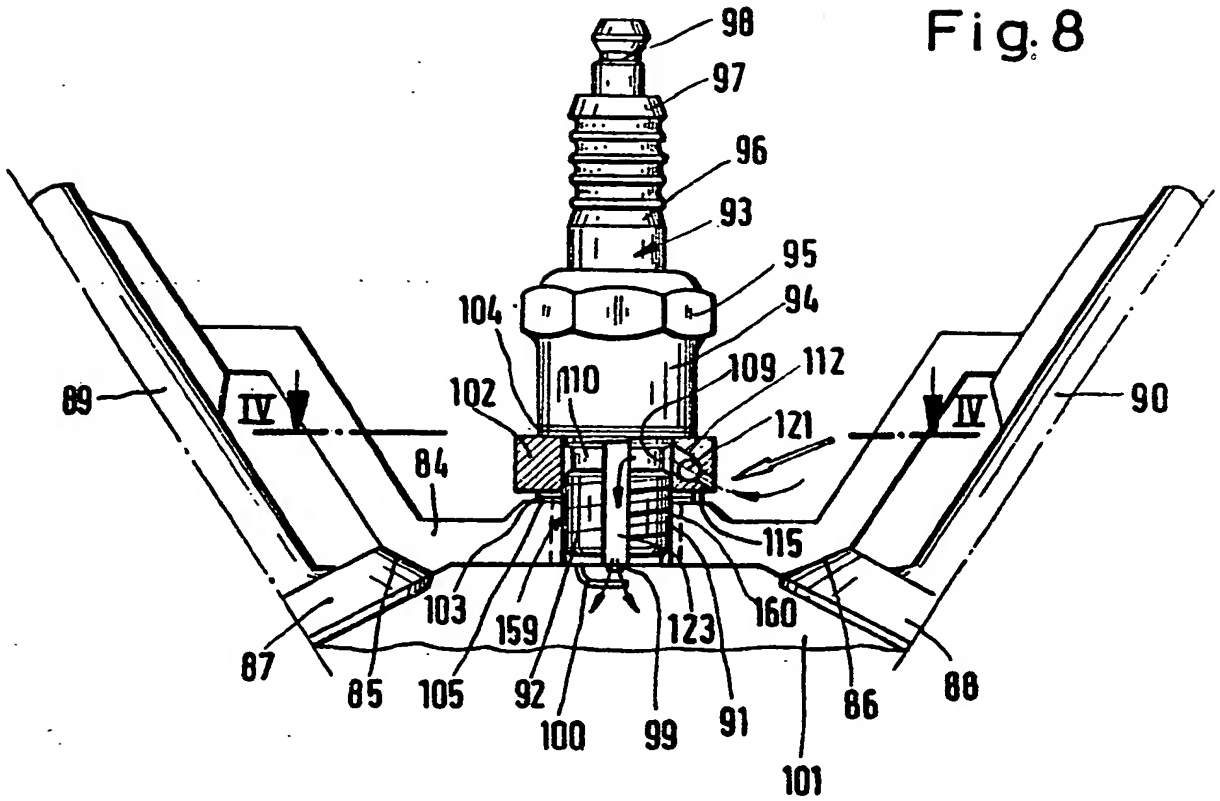


Fig.7

Fig.8



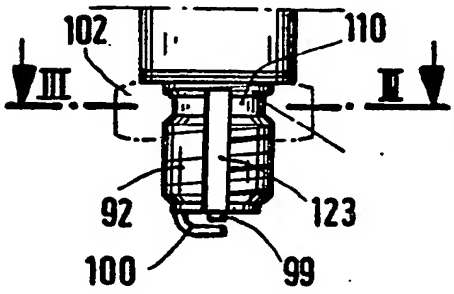


Fig.9

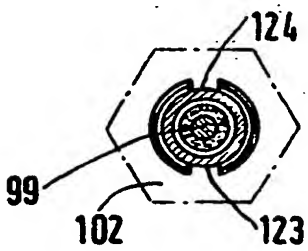


Fig.10

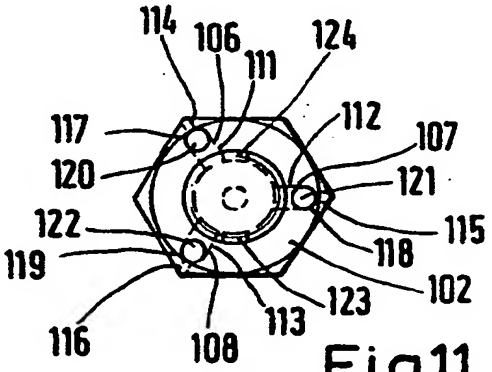


Fig.11

Fig.12

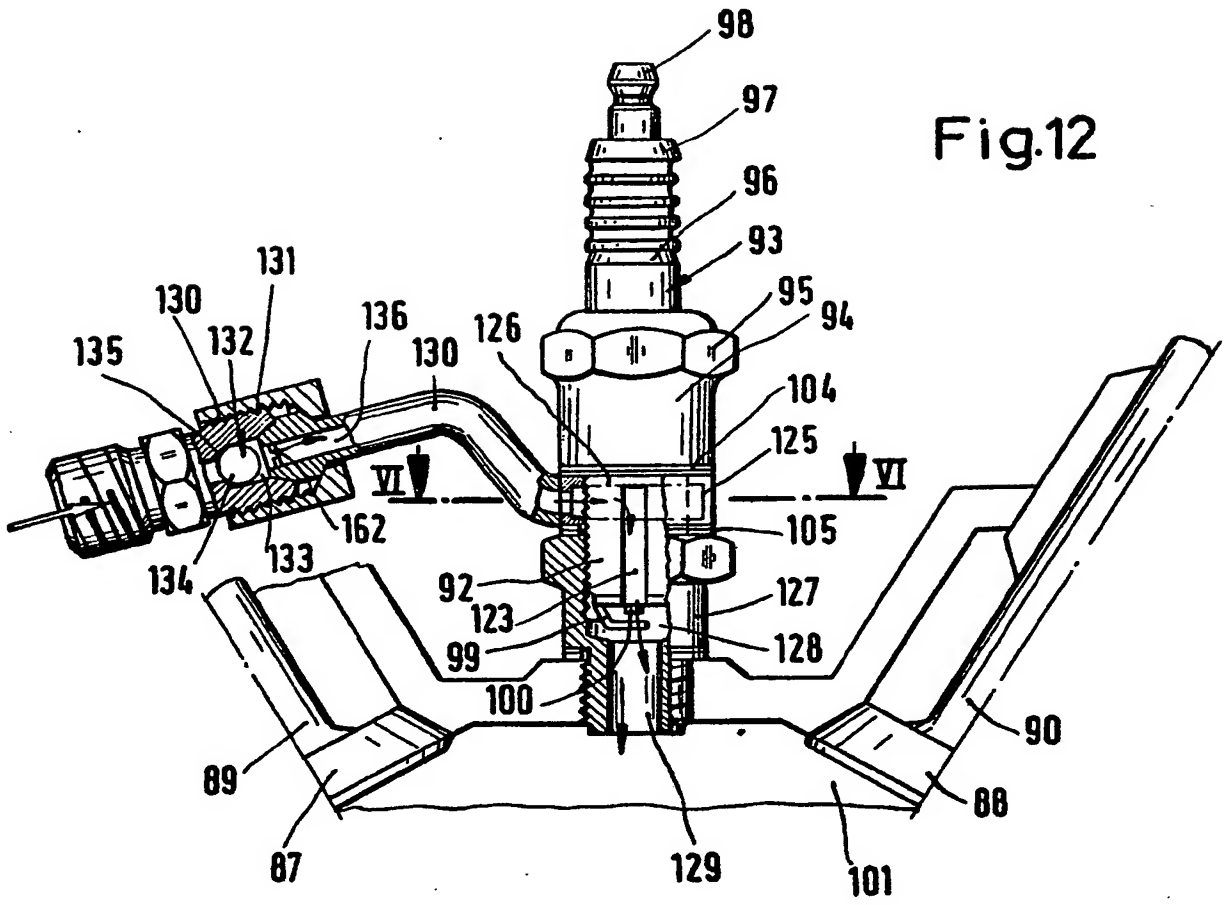
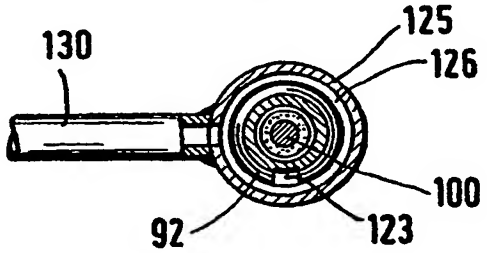


Fig.13



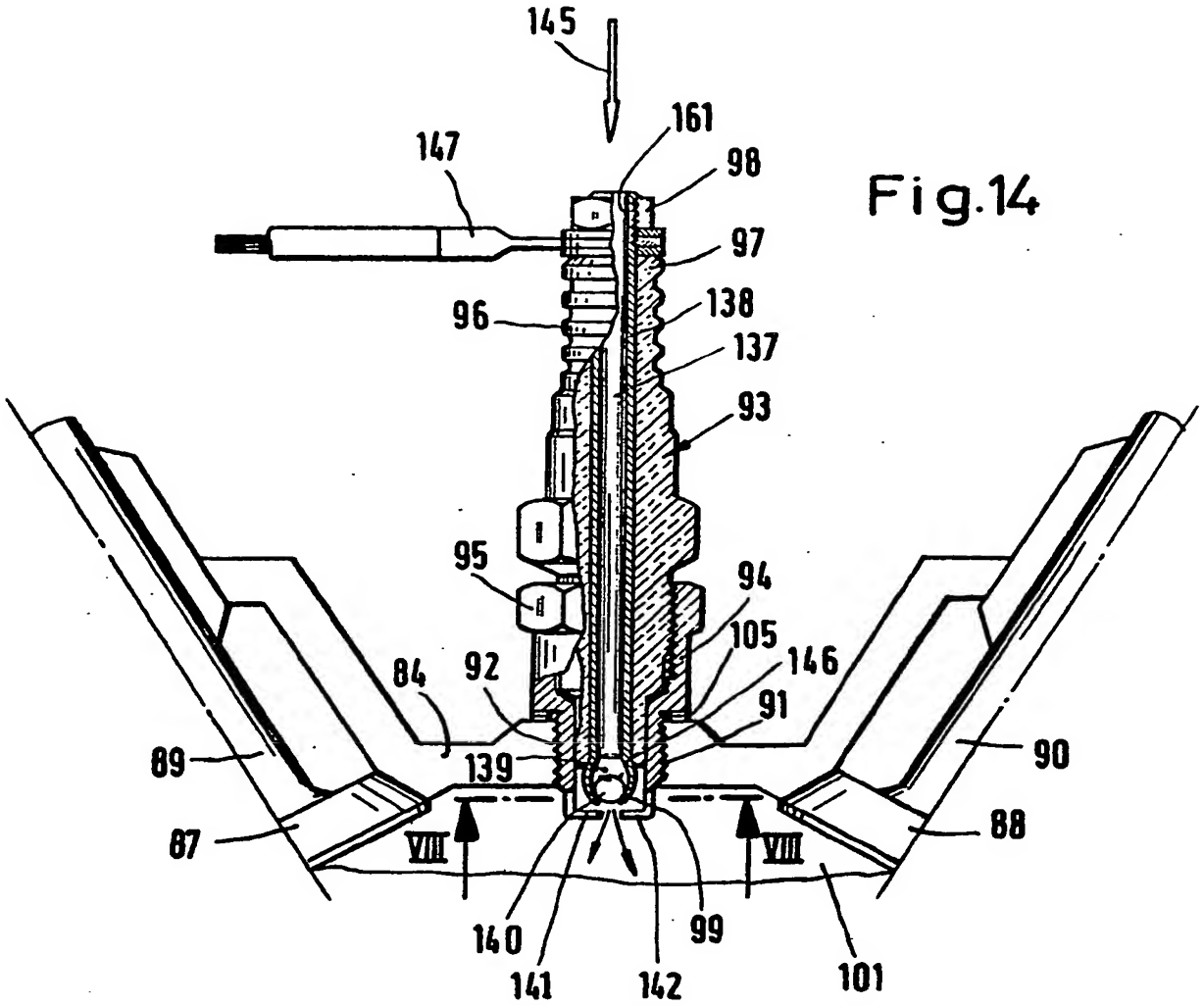


Fig.14

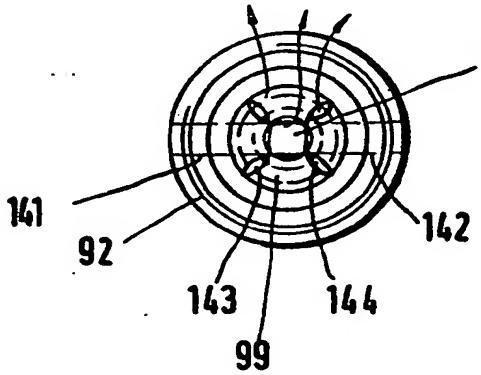


Fig.15

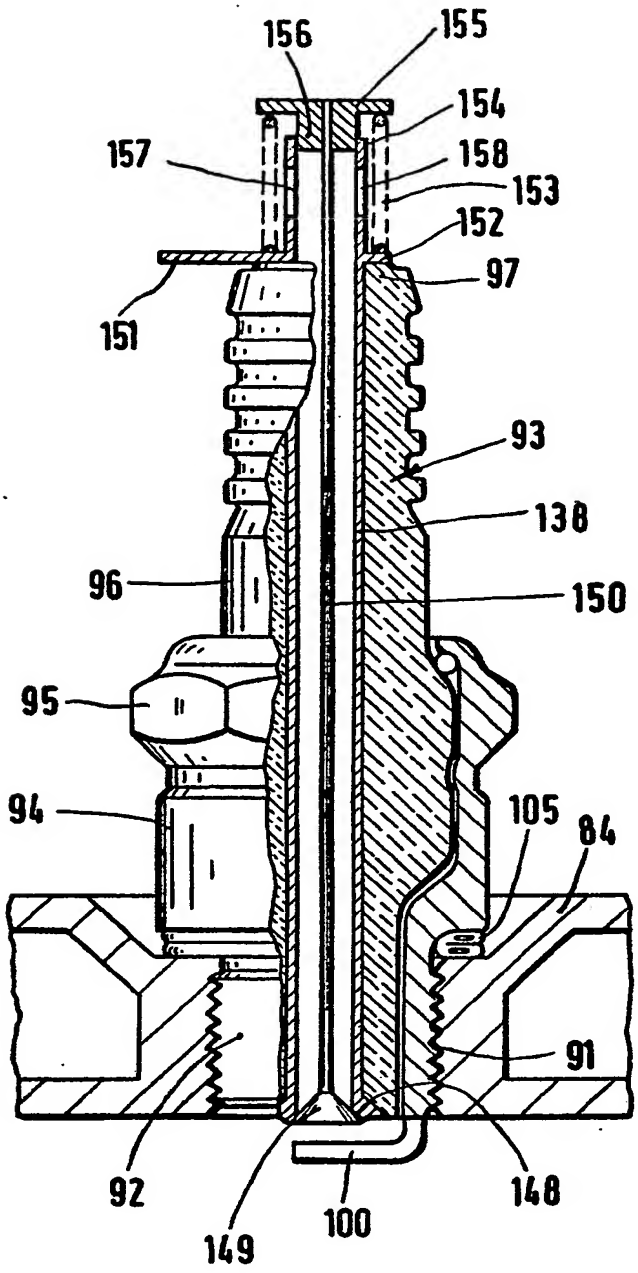


Fig.16

SPECIFICATION

Pollution and ignition control in an internal combustion engine

The present invention relates to an internal combustion engine with means for improving the ignition quality and exhaust gas cleanliness, and a spark plug for an internal combustion engine of this type. Thereby, the invention relates to an internal combustion engine comprising controlled inlet and exhaust valves, an ignition promoting means consisting of one of the parts spark plug, injection nozzle and/or heater plug, and an additional inlet of the ignition promoting means whereby the inlet is suitably provided at the ignition promoting means or intermediate this means and the working space in which a piston is movable, and an inlet valve and an exhaust valve and means for ignition promotion are respectively associated with this working space.

The invention, furthermore, relates to a spark plug for internal combustion engines.

Internal combustion engines of the type under consideration may be of the Otto type or of the Diesel type designs. The engines may operate as two-stroke engines or four-stroke engines.

It may be understood that the working space is arranged within a cylinder and that an internal combustion engine may likewise include several cylinders with the associated means and likewise, correspondingly, several pistons cooperating with a crankshaft. The invention is applicable to internal combustion engines with reciprocating pistons or with rotary pistons. In engines with reciprocating pistons the inlet and exhaust valves of the internal combustion engine will be driven by cams through valve stems.

The ignition promoting means is arranged in the cylinder head. In a conventional two-stroke or four-stroke engine, this ignition promoting means is a spark plug, and in a Diesel type engine to which the invention likewise pertains, this ignition promoting means may be an injection nozzle or a heater plug whereby the injection nozzle is connected to a source of pressurized fuel.

In Diesel engines is known an antechamber as a combustion space downstream of the injection nozzle and above the working space. There are likewise known Diesel engines having a piston top with a cavity wherein the injection nozzle extends directly through the cylinder head and opens into the working space, in engines without antechamber or prechamber.

With respect to an internal combustion engine in which the movement of a piston within a cylinder delimits a working space and during the course of a working cycle the working space is enlarged during at least the power stroke when a fuel air mixture has been ignited, and the working space is reduced at least during the compression of the fuel mixture, there are controlled valve assemblies whereby at least an exhaust valve is arranged on the cylinder head and in the case of a two-stroke engine a feed of fuel or respectively of a fuel air mixture is effected through the piston when the latter is in its bottom dead center position. With a four-stroke engine inlet and exhaust valves may be provided in the cylinder head in which is also mounted the spark plug.

Engines of this type may include upright cylinders with reciprocating pistons for driving a crankshaft. The valves arranged in the cylinder head are actuated according to the operating cycle by a camshaft through push rods and tappets. In a design, in which the cylinders are arranged in a rotor that rotates within a casing having a cylindrical cavity, the housing includes inlet and exhaust means and spark plugs at predetermined locations.

Also included are prior art so-called rotary piston internal combustion engines having a casing particularly of a trochoidal configuration in which rotates a piston as rotor which is of an arc-triangular configuration. With this design, there are likewise provided working spaces which are being enlarged for intake puproses, are being narrowed for compression purposes and are again enlarged by the expanding ignited gaseous mixtures.

The invention relates to all of these internal combustion engine designs which include a spark plug either in the cylinder head or at a location on the casing at which the fuel air mixture is compressed.

In engines of this type, it is likewise known to provide a layer charge by introducing an additional fluid.

It is known to provide, particularly in the region or vicinity of the spark plug, a prechamber at which is arranged the spark plug whereby a rich mixture is sucked into the prechamber and is ignited therein, in order to ignite a lean mixture within the working space. These conventional designs necessitate a special design of the cylinder head, and these designs are relatively complicated. The realization costs, are, therefore, considerable, and it is not readily possible to convert existing engines that are already in usage.

The invention is based upon the object of improving prior art internal combustion engines so that by admitting the additional fluid in a prechamber there will be generated an ignitability per se by which is improved the ignition out of the prechamber in the working chamber whereby is achieved a favorable distribution of a predetermined fluid by the feed of which is provided a simple design whereby, furthermore, in combination with an ignition promoting means, it is intended to provide a spark plug by which may be realized, without an expensive additional element, an engine into which may be fed a flowable fluid into the working space in the immediate vicinity of the spark plug.

This object is achieved, in an internal combustion engine comprising controlled inlet and exhaust valves, an ignition promoting means and an additional inlet in the vicinity of the ignition device, by the fact that the additional inlet is provided through a valve assembly in the vicinity of the ignition device.

Under this point of view, there are provided two types of embodiments.

In the one embodiment wherein the additional inlet of the engine is of a circular design and disposed symmetrically and intermediate of the ignition promoting means and the working space, an advantageous embodiment provides that an additional inlet valve for the fluid is provided directly intermediate the working space and means for at least promoting the ignition symmetrically of the ignition promoting means, and the annularly arranged inlet is controllable by a freely movable annular valve body.

In the other embodiment, the object is achieved, particularly in combination with a spark plug, by the fact that feed channels for feeding a flowable fluid into the working space of a cylinder of the engine are arranged directly at the spark plug, and that at least one valve assembly is provided in connection with these feed conduits. In this context is particularly provided the special design of a spark plug which is known as conventional thread-mounted element for internal combustion engines and effects in the inventive embodiment simultaneously the feed of an additional fluid, particularly under the control by a vacuum in the working space. This allows not only, without any additional elements, to introduce another fluid in the vicinity of the spark plug, i.e. at the location of the ignition electrodes, but the additional fluid enters the working space likewise in the immediate vicinity of the ignition electrodes. Furthermore, assembly, adjustment a.s.o. are greatly simplified because merely the inventively designed spark plug has to be thread-mounted in the conventional manner.

When talking of a fluid for feeding in combination with the additional inlet with the embodiment in whch the additional inlet is disposed symmetrically and intermediate of the ignition promoting means and the working space and is of an annular configuration, this additional fluid may not exclusively but preferably consist of ambient air that may be sucked in under normal pressure. Taking in out of ambient air by itself provides considerable advantages because there are not required special expedients for arranging a source of pressurized air that in turn necessitates a compressor, or a mixture.

This, however, achieves an enrichment in oxygen which has a favorable effect, due to the distribution thereof, and by introduction merely by suction effects there occurs an adaptation to operating conditions. It may be understood that likewise fuel may be fed whereby is advantageously included that the fuel is taken in by suction effects. In combination with the annular valve body it is especially significant that this valve body is freely movable, i.e. may be moved by the internal pressure within the working space. This implies that during the suction stroke the valve body will be lifted off and air will be sucked in, that during a compression stroke the additional inlet valve is closed, this operative position is maintained during the power stroke upon ignition, and that at the end of the exhaust stroke the annular valve body may be lifted off. When talking of an ignition promoting means, this applies with this embodiment in its general form for example to a heater plug but includes, however, likewise an ignition effecting means in the form of a spark plug and/or an injection nozzle. In this context it should be pointed out that the additional inlet may also be connected to a source of a pressurized fluid.

Surprisingly, it has been found that the invention provides an internal combustion engine wherein the normal design of the engine need not be altered, by merely inserting into the threaded mounting po tion for the means for at least promoting the ignition, particularly a spark plug, a special additional intermediate valve ahead of the spark plug, in order to achieve an easier performance and an improved combustion.

Under this point of view, an advantageous embodiment provides that the prechamber and the additional inlet valve at the same consist of an intermediate element which may be threadedly engaged, by a threaded mounting portion, into a threaded bore of the cylinder head for the ignition promoting means, and includes a threaded bore for the mounting thread of the ignition promoting means above the prechamber in which is arranged the valve. In this context, it should be pointed out that the above mentioned prechamber may optionally consist of a prechamber in addition to the prechamber which may for example be provided as a combustion chamber within the cylinder head of a Diesel engine. The embodiment in the form of an intermediate element has the considerable advantage that conventional engines may be converted without any alterations to these engines because merely the intermediate element with the additional inlet has to be mounted intermediate the means for at least promoting the ignition and the conventional threaded aperture for receiving this means. The conversion is, therefore, reversible. This may, in some cases, be suitable under certain conditions of usage of the engine. By the intermediate element, the invention especially provides the possibility to convert at low cost any conventional engine having normal spark plugs, injection nozzles or heater plugs. Even when in the case of a Diesel engine necessitating a high rigidity cylinder head the additional prechamber leads to a somewhat increased working space, this will be compensated by the fact that additional fluid is introduced into the prechamber, and in the case of a particularly large space, this fluid may also be introduced under pressure. The pressurized fluid source may readily be mounted as a separate unit externally of the engine.

With an embodiment in which the valve includes an annular controlled inlet disposed symmetrically of and below the means for at least promoting the ignition, particularly the ignition electrodes, and in which the annular valve body is freely movable within a prechamber in dependence upon the pressure in the working

space, the intermediate element is advantageously designed as a valve housing and includes, about a center bore, an outwardly directed shoulder into which opens the inlet, and which shoulder forms a valve seat for a valve body the opposite-end abutment of which is formed by the annular end of a fitting. An annular fitting of this type may be threadedly engaged into the upper end of the intermediate element and include above this end a threaded bore for the mounting thread of the spark plug. This consitutes an embodiment which may be readily manufactured, is free of maintenance and suitable for any type of engine employing similar means or respectively spark plugs. In this context, an advantageous characteristic resides in the fact that the inlet is formed as an annular conduit that extends coaxially of the valve housing center axis, and radial bores extending through the housing from the outside communicate with the annular conduit.

It is likewise contemplated as suitable that the inlet is formed by bores extending parallel of the valve housing axis, the bores are spaced about a circle within the shoulder and communicate with the ambient air by radial bores in the wall of the valve housing. A particular characteristic resides thereby in the fact that the radial bores open at the outside into an annular groove that is arranged at the outside of the valve housing, in thus virtually providing an anular channel. In this context an advantageous embodiment consists in the fact that a housing type closure in the form of an annular chamber with intake duct surrounds the outer openings of the radial bores. In this manner, the feed of a fluid, particularly air, may be equalized by keeping the intake manifold free.

In the embodiment with the free intake manifold it must be considered that before the annular valve body will hit its seat during the exhaust stroke a certain quantity of the mixture, particularly a gaseous combustion mixture, will enter the housing or respectively the intake manifold. This manifold or tunnel prevents that this quantity of possibly imperfectly combusted mixture will enter into the ambient air but will remain at the additional inlet valve and be drawn in again first of all, together with the sucked-in fluid, particularly air. This constitutes an especially advantageous characteristic with respect to operation.

This operation may be improved further by providing an opposite-end abutment for the valve body with profilings, particularly radial grooves.

Also in connection with the accommodation of the additional inlet directly at the spark plug whereby for the following explanations it should be borne in mind that when talking of a spark plug these explanations likewise relate to a correspondingly designed engine, there consists an advantageous embodiment in the fact that the valve assembly in combination with the spark plug is in the form of a check valve. Such a check valve operates under the control of the pressure existing within the working space and in one of its embodiments in the manner as above described. Surprisingly, it will be found that likewise conventional engines may be converted for a more advantageous operation leading to fuel economy and improved exhaust gas cleanliness by advantageously admitting as a flowable fluid air for improving the ignition quality.

In an advantageous embodiment the mounting thread is provided with at least one axially downwardly extending groove, and at the mounting thread of the spark plug is provided a feed assembly communicating with the at least one axially downwardly extending groove by an annular channel. When talking of at least one groove, it may be understood that this language likewise is intended to include several grooves that are spaced about the circumference so that consequently, within the meaning of the above mentioned already proposed embodiment, may likewise be provided a fluid annulus, particularly in an air annulus, directly within the working space and at the ignition electrodes.

In this context, it may not be excluded that the at least one axially downwardly extending groove may be arranged on the mounting thread of the cylinder head whereby in this case the annular channel is open at its lower end, in order to provide communication with these grooves. In combination with the spark plug it is, however, preferred that the at least one axially downwardly extending groove is arranged on the mounting thread of the spark plug.

In accordance with a suitable embodiment, the annular channel may be provided in the feed assembly. This has the advantage that the spark plug requires as little modification as possible. According to another suitable embodiment the annular channel may be provided in the form of an annular groove in the region of the mounting thread. By this, the design characteristics are to be found in the spark plug which constitutes a part that is adapted to be mounted on an engine which itself remains unmodified.

With respect to the spark plug, there should be remarked in this context that there will suitably be used a spark plug with a long mounting thread because in this case even when being used at thin cylinder head walls, there is still available on the mounting thread a sufficient portion for mounting the feed assembly and the flanking sealing rings. In this context is included a conical seat.

As to the spark plug, there should be pointed out generally that this spark plug includes a center electrode and at least a ground electrode whereby likewise a greater number of annular ground electrodes may be provided.

In accordance with a particularly advantageous embodiment the feed assembly may consist of a nut member adapted to be threadedly engaged on the mounting thread and having passages that open toward the outside and toward the annular channel, the passages respectively defining valve seats, and wherein a movable valve member is disposed within an inner enlarged portion of the passages. This embodiment may be realized with

a spark plug of a conventional design having particularly a long mounting thread wherein the spark plug has been modified by relatively minor machining.

According to another advantageous embodiment the feed assembly may consist of an annular adapter for the mounting thread, the adapter being retained intermediate gaskets on the mounting thread, and the annular channel may be connected by a feed conduit with a check valve the valve seat of which is disposed on a valve chamber wall remote from the connection to the annular channel. This allows to provide a favorable arrangement even on an advantageous long mounting thread in employing sealing rings whereby with respect to the feed line should be pointed out that this feed line may also lead to a manifold for all spark plugs of an engine. The valves, however, are suitably arranged intermediate the manifold and the feed conduits.

In another particularly advantageous and preferred embodiment the feed channel may extend centrally through the spark plug and include, at its exit end in the region of the center electrode, a check valve adapted to close in the direction of the terminal end of the spark plug. The terminal end is thereby the end disposed externally of the working space and includes the electrical connection for the center electrode. It is not excluded to provide the valve likewise at this end. The arrangement at the exit end is, however, preferred.

In this embodiment the additional fluid is introduced directly into the region of the electrodes. By the inflow which may optionally be enhanced by increasing the fluid pressure, there will simultaneously be obtained a self-purging effect in the region of the electrodes. This effect constitutes a respective further improvement of operation.

In a preferred embodiment the center electrode is of a tubular design and includes at its end adjacent the ground electrode an enlarged portion defining a valve chamber for a check valve body whereby the end facing the ground electrode is designed as a permeable cage and at the inner end of the valve chamber is provided a valve seat. Surprisingly, it will be found that with this arrangement and when the electrode spacing always remains constant there will be ensured an effective fluid feed whereby the cage-like modification leads to the jet type discharge of the fluid in radially and downwardly inclined directions.

According to another advantageous embodiment the center electrode is of a tubular design and defines at its inner end a valve seat for a valve body which is mounted on a shaft that is guided by at least a tubular portion of the center electrode whereby is provided a spring for biasing the shaft so as to urge the valve body against the valve seat. Although when the fluid enters the working space the valve body may project downwardly from the center electrode, the valve body engages a seat in a defined position at the ignition time after compression of the mixture so that there will be ensured a sufficient spacing definition. This last described embodiment is also advantageous in combination with ground electrodes in the form of so-called side electrodes.

In the last described embodiment the shaft is advantageously guided by the spark plug and mounts, at its projecting end, a spring cap whereby a spring is arranged intermediate the spring cap and the upper end of the spark plug and the spring cap is guided at the tubular center electrode which includes apertures open toward the outside for a fluid inlet below the spring cap. The spring is thereby dimensioned so that it may be contracted by the suction effect in the working space. The dimensioning is thereby likewise dependent upon the cross-sections of the valve body, of the weight of the valve body and s.o.

The invention also relates to a cylinder head of an internal combustion engine whereby in this cylinder head is provided a mounting thread for the spark plug, and the described axial grooves serving as feed channels extend through this cylinder head mounting thread. The mounting thread of the spark plug thereby need actually not be interrupted. This statement should be understood in the context of the above explanations for clarifying an alternate arrangement of the mounting thread on the spark plug at the one hand and within the cylinder head on the other hand.

In the following, the invention will be described more in detail with reference to preferred embodiments shown in the appended drawings wherein

FIGURE 1 is a schematical fragmentary elevational view of a cylinder head with a valve in accordance with the present invention;

FIGURE 2 is a sectional view along the line II—II of FIG. 1 wherein, however, the tunnel is omitted;

FIGURE 3 is a sectional view along the line III—III of FIG.1, for illustrating a particular modification;

FIGURE 4 is a schematical lateral elevational view of an engine having a cylinder head according to FIG. 1;

FIGURE 5 is a view similar to FIG. 1 of a modified embodiment;

FIGURE 6 is a schematical partly sectional lateral elevational view of an injection nozzle in the cylinder head of a Diesel engine in accordance with an inventive embodiment;

FIGURE 7 is a sectional view of a Diesel engine with a combustion chamber above the working space for the explanation of the arrangements of intermediate elements in accordance with the present invention;

FIGURE 8 is a fragmentary sectional view of a cylinder head with a spark plug designed in accordance with the present invention;

FIGURE 9 is a fragmentary view of FIG. 8;

FIGURE 10 is a sectional view along the line X—X of FIG. 9;

FIGURE 11 is a sectional view along the line

XI—XI of FIG. 8;

FIGURE 12 is a partly sectional view similar to FIG. 8 of another embodiment of the invention;

FIGURE 13 is a sectional view along the line XIII—XIII of FIG. 12;

FIGURE 14 is another partly sectional view subtantially similar to FIG. 8 of another embodiment;

FIGURE 15 is a sectional view along the line XV—XV of FIG. 14; and

FIGURE 16 is a partly sectional lateral elevational view of a spark plug within a cylinder head, for explaining another embodiment of a spark plug.

Before referring to FIG. 1, there should be pointed out with respect to FIG. 4 that a cylinder 2 extends from a crankcase 1. A crankshaft 3 is mounted in the crankcase 1 at face walls thereof which extend in planes that would be parallel to the plane of the drawing. At the crank pin 4 is rotatably mounted a connecting rod 5 which is connected to the piston 7 open at its bottom by the gudgeon pin 6. This piston is sealed aginst the cylinder 2 by piston rings.

In the cylinder head 8 are arranged an inlet port 9 and an exhaust port 10, and these ports are connected to respective intake and exhaust conduits 11, 12. In one embodiment, the intake conduit 11 communicates with a carburettor or respectively throttle assembly 13 the throttle valve of which is identified by 14, and this throttle assembly is in turn connected to a source of fuel 15. In the inlet port 9 is provided an inlet valve 16, and in the exhaust port is provided an exhaust valve 17. Both valves are controlled through valve stems 18, 19 by tappets 20, 21 respectively which are driven in the conventional manner by a camshaft 22. With these springs are associated in the conventional manner springs 23, 24 which are adapted to urge the valves 16, 17 against their seats. The camshaft 22 is driven by the crankshaft 3 through a transmission 25. The transmission normally provides a transmission ratio of 1:2. In the cylinder head 8 may for example be arranged an ignition device 26.

In the cylinder head 8 may be provided an additional injection device 28 for feeding a liquid. This injection device 28 is arranged directly adjacent the ignition device 26. By a conduit 29 the injection device may communicate with an injection pump 30 which is driven by the camshaft 22 through a gear train 31. In the connection between the drive member, i.e. the gear train and the injection pump may optionally be provided a mechanical abutment control or an actuating means of another type for initiating the injection operation at a predetermined time.

The injection pump 30 may communicate through a line 32 with a source 33 of a fluid which may be either air, pure water, a water oil emulsion, a water alcohol mixture or a mixture of this type with the addition of oil which is preferred, or a fuel or respectively a fuel air mixture, i.e. a mixture of a carburettor type composition.

FIGURE 1 illustrates a particular inventive embodiment insofar as the cylinder head 8 includes, between the inlet port 9 and the exhaust port 10, a threaded aperture 34 into which is threadedly engaged the threaded mounting portion 35 of a valve housing 36 whereby sealing may be effected by a sealing gasket washer 37. The valve housing includes a center bore 38 which opens downwardly toward the working space and includes an outwardly directed shoulder 39 at a spacing from the cylinder head. Into this shoulder opens an inlet identified generally by 40. This shoulder 39 forms a valve seat for a valve body 41 in the form of an annular disc having an inner opening 42 corresponding to the bore 38 and being guided externally at the upwardly extending wall of the valve housing laterally of the shoulder. into the valve housing 36 is threadedly engaged a fitting 43 having a corresponding center bore 44 and a shoulder type inwardly directed flange 45. This flange 45 forms an opposite-end abutment for the valve body 41 whereby the spacing may suitably be selected by interposing a gasket 46. The opposite-end abutment may also be formed by the facing edge of the housing of the means for the at least promoting the ignition. It is important that likewise in connection with the center bore 44 is provided a passage toward the ignition electrodes 37 which are arranged in the center axis of the bores and above the range of movement of the valve body 41. Into an upwardly open threaded bore 48 is threadedly mounted the mounting thread 49 of the spark plug 26.

The inlet 40 comprises according to FIGS. 1 and 3 a number of vertical bores 50—53, . . . into which are drilled from the outside with respect to the valve housing 36 radial bores 54, 55, 56, ... This provides an unobstructed passage which is controlled by the valve body 41.

It may be understood that the vertical bores 50 to 53 may likewise be formed by a continous annular conduit 57 about the circumference which conduit is shown in broken lines in FIG. 3 and into which open likewise the bores 54 to 56 connected to the outside. When within the working space above the piston 7 and below the cylinder head 8 exists intake stroke conditions, the annular valve body 41 is lifted off the shoulder 39, and fluid is being sucked in annularly through the inlet bores. When after the intake stroke the direction of the piston movement is reversed and there occurs compression, the fluid exiting through the openings open toward the outside ensures that the valve body blocks the outlet. The particular means according to FIG. 2 contribute to this action. According to FIG. 2 the downwardly directed side of the flange 45 defining an opposite-end abutment for the valve body 41 is provided with radial grooves 58 to 60 whereby the "sticking" of the valve body in its upper position is prevented. During the working stroke the described position of the valve body is maintained due to the pressure within the working space. The same applies to the exhaust stroke during which, however, the exhaust valve is open. Thereby it is not excluded that at the end of the

exhaust stroke the valve body 41 may lift off so that a certain quantity of fluid may escape through the intermediate valve intermediate spark plug and working space.

As apparent from FIG. 1, the outer openings of the radial bores 54 to 56 are arranged in an inwardly recessed annular groove 61. Suitably, this annular groove is surrounded by a housing 62 which is connected to an intake tunnel 63. This intake tunnel may particularly communicate with ambient air. This intake tunnel which particularly faces away from the cylinder head 8 is of a length selected so that non-combusted mixture discharged by the annular channels 54 to 56 may at most move within the tunnel 63.

In accordance with FIG. 5 it is also contemplated that the intake tunnel 63 is connected to a source, i.e. either a source 64 of pressurized air, particularly as secondary air for two-stroke engines, or a source 64′ of fuel, or to a carburettor 64″, i.e. to a source of a fuel air mixture. In all cases, there will be controlled, below the ignition electrodes 47, a fluid annulus in dependence upon the internal pressure within the working space below the cylinder head 8, i.e. the valve body 41 is virtually freely movable and provides for this reason, in dependence upon the inner pressure within the working space of the cylinder 2, the required layer charge which in case that the threaded aperture 34 is arranged concentrically of the movement axis of the piston 7 leads to an annular buffer charge within the working space.

According to FIG. 6 is shown the cylinder head 8′ of a Diesel type engine, the cylinder head having a greater thickness than in the case of an Otto type engine. In this cylinder head is provided a threaded aperture 34′ with an extension bore 65 having a lower shoulder from which extends a reduced diameter conduit 66 toward the working space 67 of a cylinder. In the illustrated embodiment the valve housing 36′ is arranged in correspondence with the actual injection device 68 at the lower end, i.e. is provided with a projection 69′ that projects into the extension bore 65, and with the so-called threaded mounting portion 35′ which may be threadedly engaged into the threaded aperture 34′. The corresponding parts of the injection device 68 are indicated by 69′ and 35″. It is pointed out that into the valve housing 36 above the shoulder 39 is threadedly mounted the fitting 43 of an armature forming the opposite-end abutment 45 and having at its upper end a threaded bore 48′ which is threadedly engaged into the injection device 68. The remaining parts are identified by the same reference numerals, particularly the valve body, the inlet a.s.o. inclusive of the intake tunnel 63 shown in dashed lines.

In FIG. 7 is shown the principle of a Diesel engine with piston 7′. By the crankshaft 3 is driven a camshaft 22′ which drives valve stems 72 of an inlet or exhaust valve 74 through push rods 70 and tappets 71. In the view shown in the drawing, the inlet and exhaust valves would be arranged one behind the other. The crankshaft 3 furthermore drives an injection pump 73 which is connected to the injection device 68. In the shown embodiment the top of the piston includes a depression 75 into which opens a feed or "shot" channel 76 from a precombustion chamber 77 when the piston is in its top dead center position. Into this precombustion chamber 77 opens on one side the conduit 66 leading to the injection device 68 and extends on the other side a heater plug 78. With respect to the injection device 68 may be provided an intermediate element 82 (according to FIG. 6 — 36′). In FIG. 7 is shown how an intermediate element 83 is arranged intermediate the precombustion chamber 77 and/or the heater plug 78 which is conventionally connected to a voltage source not shown. Furthermore may be seen the connection 79 between the injection pump 73 for a fluid and the injection device 68. In both cases may be seen the openings of radial bores that correspond to the bores 54 to 56 in FIG. 1.

FIGURE 4 illustrates an additional modification insofar that a conduit 80 with a throttle valve 81 opens into the intake conduit 11, particularly in a position immediately upstream of the inlet port. This throttle is controlled in a manner not shown in detail so that the throttle is closed in normal operation, i.e. when fuel is supplied by the position of the accelerator pedal, but is again opened when a torque is applied to the engine, i.e. the engine is being "pushed". In the idling condition, this throttle valve 81 closes.

A throttle actuating lever may be connected to actuating means in the form of mechanical traction members or linkages, or to an electromechanically operated controller which may be energized for example in dependence upon the position of the accelerator pedal, as described in the pending U.S. patent application Serial Number 838,397 or in the pending British patent application File No. 41491/77.

The purpose of controlling the additional throttle valve for controlling an additional air feed when a torque is applied to the engine, ie. when the throttle valve 14 is in its closing position, is to reduce hydrocarbons within the exhaust.

When a torque is applied to the engine there will normally result the drawback that there is formed a vacuum which entrains fuel particularly through an idling jet and causes a mixture which is virtually an over-rich mixture. This not only leads to an unnecessarily high fuel consumption but likewise to a less favorable combustion, particularly when a torque is acting on the engine. By the additional arrangement of the conduit 80 with the throttle valve 81, this deficiency is largely eliminated. Although the invention is described with reference to a reciprocating-piston type engine, it is pointed out that rotary-piston type engines are included into the inventive design.

FIGURE 8 illustrates a portion of a cylinder head 84. In this cylinder head are arranged an exhaust port 85 and an inlet port 86 which ports define valve seats. In these valve seats are movable valve

bodies 87, 88 respectively. These valve bodies are mounted on valve stems 89, 90 respectively which may be actuated in the conventional manner by a camshaft through tappets not shown. The valve shafts or respectively the valve bodies 87, 88 are kept in permanent engagement with the tappets by springs not shown.

The cylinder head 84 includes a threaded bore 91 which may likewise be termed cylinder head mounting thread. Into this bore 91 is threadedly engaged the mounting thread 92 of a spark plug indicated generally by 93. This spark plug 93 includes, oppositely the mounting thread 92, an outwardly projecting housing shaft 94 having a profiled portion 95 for threadedly mounting the spark plug. Above the housing shaft the spark plug is extended by an insulator, particularly a pyranite insulator 96. From the outer insulating head 97 projects the terminal nut 98 for the center electrode 99. At least one ground electrode 100 is connected to the plug housing 94.

According to FIG. 8 the mounting thread 92 is with respect to the threaded bore 91 of a length so that in a thread-mounted position in which the electrodes 99, 100 are disposed within the working space 101 of a cylinder, a feed assembly 102 may be arranged intermediate the housing shaft 94 and the seat 103 at the cylinder head whereby this feed assembly 102 may be sealed at its bottom and top annular surfaces by gasket inserts 104, 105. In the illustrated embodiment, the feed assembly 102 is in the form of a nut member adapted to be threadedly engaged onto the mounting thread 92. This nut member is sealingly clamped between the gasket inserts 104, 105.

According to FIG. 11, the nut member may for example comprise three outwardly directed passages 106 to 108. These passages are suitably inclined downwardly from the center toward the outside. The inner openings 109 (FIG. 8) of these passages terminate in the region of an annular channel 110 which is arranged in the mounting thread 92 below the housing shaft. The passages 106 to 108 include, inwardly toward the annular channel 110, enlarged portions 110 to 113 and toward the outside, restricted portions 114 to 116. The restricted portion thereby serves simultaneously as a metering nozzle for metering the amount of air. In the transition between the inner and outer portions are provided valve seats 117 to 119 for a valve body 120 to 122 respectively. This valve body is spherical and arranged in the enlarged portion of the passages. The valve body is retained in this portion so as not to become lost by the mounting thread 92 and lifts off from its valve seat 117 to 119 when a suction effect is created.

The annular channel 110 formed in this case within the mounting thread 92 communicates with axially and downwardly extending grooves 123, 124. These grooves open directly adjacent the electrode assembly, and by these grooves the pressure existing within the working space 101 is transmitted to the valve bodies 120 to 122.

The illustrated embodiment discloses a relatively simple design of a normal spark plug for feeding an additional fluid.

For completeness' sake it should be pointed out that the grooves 123, 124 — and optionally only a single groove — may likewise be provided within the thread of the threaded bore 91. In this case, the annular channel would suitably be provided in the nut member 102 which correspondingly includes downwardly extending passages which, however, would be sealed by the gasket insert 105.

According to FIGS. 12 and 13 in which similar parts are identified by the same reference numerals the feed assembly below the housing shaft 94 is arranged in the form of an annular adapter 125 which may be threadedly mounted on the mounting thread 92 or slidably engaged thereon. For better understanding, the embodiment illustrates a spark plug with a short mounting thread 92 and an intermediate member 127 which clamps the adapter 125 intermediate the gasket inserts 104, 105. The intermediate member 127 is shown merely as an example. It should be pointed out that the mounting thread 92 may likewise be engaged directly into the cylinder head so that in this case the lower gasket insert 105 directly engages the cylinder head and the electrodes are disposed within the working space 101. The adapter 125 includes the inwardly open annular channel 126 which communicates with the at least one axially extending groove 123. In this case, the enter electrode 99 and the ground electrode 100 are arranged within a chamber 128 of the intermediate member 127, and this chamber 128 communicates with the working space 101 by an unrestricted channel 129.

The adapter 125 with the annular channel 126 is connected by a feed conduit 130 in which is provided a check valve 132 by means of an armature assembly 131. This armature delimits a valve chamber 133 in which is freely movable a valve body 134. The valve seat 135 is thereby arranged at the chamber wall remote from the connection 136 to the annular channel 126. The valve, therefore, opens under suction conditions within the working space and closes under pressure in the working space. It may be understood that the valve body 134 which is shown as a ball may likewise be of a different configuration and be spring-biased. It should also be understood that the connecting armature may be connected to a pressurized source the pressure of which is selected with respect to a biasing pressure of the valve body and the working or suction pressures within the working space.

The embodiment according to FIGS. 8 to 13 provides the advantage that the center electrode may be connected in the conventional manner thorugh an electrically conductive special melt. By this, the heat transfer is favorably affected.

According to FIGS. 14 and 15 a feed channel 137 extends centrally through the spark plug 93. At its exit end in the region of the center electrode 99 toward the working space 101 the tubular

center electrode 138 is provided with an enlarged portion defining a valve chamber 139 in which is provided a check valve body 140 which is preferably freely movable or optionally spring-biased. The end of the valve chamber 139 facing the annular ground electrodes 141, 142 is of a cage type configuration with notches 143, 144. By these notches which provide a permeable cage design a flowable fluid, particularly air, may be introduced into the working space as shown by the arrow 145 when the valve body 140 is in its illustrated position. At the so-called inner end of the valve chamber 139 is defined a valve seat 146 for the valve body. The latter engages under increasing pressure in the working space this seat and thereby seals the feed channel 137. Advantageously, the cage is of a larger cross-sectional curvature than the valve body 140.

It may also be seen that an electrical connector 147 for the center electrode 138 is provided in the region of the terminal nut 98.

With the described embodiment, there will be obtained a direct enrichment with the additional fluid at the ignition electrodes. This enrichment is achieved without any modification to the cylinder head.

The embodiment according to FIG. 16 illustrates another modification. The center electrode 138 is again tubular and at its inner, i.e. lower end facing the working space designed as a valve seat 148. This virtually constitutes a downwardly conically flaring portion. This embodiment provides the advantage that the part of the center electrode formed by the valve seat 148 not only remains at a fixed spacing from the ground electrode 100 but likewise provides a very favorable electrode configuration. A valve body 149 is associated with the valve seat 148. This valve body is provided on a shaft 150 which in the illustrated embodiment extends through the whole length of the spark plug 93 and the tubular center electrode extending therethrough.

In this embodiment is provided an ignition lead connector 151 for the center electrode above the insulating head 97. In this region is, moreover, provided a spring abutment 152 for a spring 153. This spring biases the shaft 150 so as to urge the valve body 149 toward the valve seat 148. It should be pointed out that the tubular center electrode 138 extends beyond the insulating head 97, and in the upper end 154 is arranged a spring cap 155 which for example may be axially movably guided by a guide portion 156 in the upper end of the tubular center electrode 138.

The guide portion 156 is of a length so that this guide portion may move in the upper end of the tubular center electrode in dependence upon the range of movement of the valve body 149 with respect to the valve seat 148. Even when the valve body engages the valve seat 148, the guide portion 156 extends into the region of the center electrode and is of such a length that there is left sufficient clearance with respect to the actual spring cap 155, in order to remove the valve body 149 sufficiently far from the tubular center electrode 138 before the spring cap 155 hits the upper end 154 of the tubular center electrode. Below the lowermost position of the guide portion 156 the tubular center electrode 138 includes externally open passages 157, 158 for admission of the additional fluid such as air or a liquid.

In correspondence with the above described effects of the restricted portions 114 to 116 in the embodiment according to FIGS. 8 to 11, the other feed means according to FIGS. 12 to 16 are likewise provided with metering devices. These metering devices may consist of in-line connected valves or throttle valves, or respectively the tubular center electrode 138, and particularly the feed channel 137 defined thereby may be provided with a restriction. According to FIG. 16 the passages 157, 158 are suitably provided with slot shaped restrictions whereby it may also be contemplated to provide in this region an adjustable sleeve for partly obstructing the passages, in order to be able to meter the admitted amounts of air in dependence upon the adjustment position. A restriction is also shown at 161 in FIG. 14.

In the embodiment according to FIG. 12 there will result a metering restriction for example at 162.

The invention also pertains to a cylinder head design wherein with reference to FIG. 8 channels 159, 160 open at their lower ends are arranged at the thread of the threaded bore 91 and communicate with the passages 106 to 108.

CLAIMS

1. An internal combustion engine comprising controlled inlet and exhaust valves, means for at least promoting the ignition consisting of one of the parts spark plug, injection nozzle and/or heater plug, and an additional inlet for a fluid comprising one of the substances air and fuel in the vicinity of the ignition device, said internal combustion engine characterized in that the additional inlet is provided through a valve assembly in the vicinity of the ignition device.

2. An internal combustion engine as defined in Claim 1 wherein the additional inlet is of a circular design and disposed symmetrically and intermediate of the ignition promoting means and the working space, said internal combustion engine characterized in that the additional inlet includes an outer open end in free communication with the ambient air, an additional inlet valve (39, 41) for air is provided directly intermediate the working space and means for at least promoting the ignition (26, 68, 78) symmetrically of the ignition promoting means, and the inlet (40) of an annular design is controllable by a freely movable annular valve body (41).

3. An internal combustion engine as defined in Claim 2 wherein a prechamber and the additional inlet valve (40, 41) are arranged as intermediate element (36, 36') on the prechamber, the intermediate element by a threaded mounting portion (35) being adapted to be threadedly engaged into a threaded bore in the cylinder head

(8, 8') for the ignition promoting means (26, 68, 78), said internal combustion engine characterized in that a threaded bore (48, 48') for the mounting thread (49) of the ignition promoting means (26, 68, 78) is provided above the prechamber in which the valve is disposed.

4. An internal combustion engine as defined in any of the preceding Claims 1—3, characterized in that the intermediate element (36, 36') defines a valve housing and includes, about a center bore (38), an outwardly directed shoulder (39) into which opens the inlet (40) and which shoulder forms a valve seat for a valve body (41) the opposite end abutment of which (45) is formed by the annular end of a fitting (43), and that the inlet is formed as an annular conduit (57) coaxially of the valve housing center axis, and radial bores (54—56) extending through the housing from the outside communicate with the annular conduit (57).

5. An internal combustion engine as defined in any of the preceding Claims 1—4, characterized in that the intermediate element (36, 36') defines a valve housing and includes, about a center bore (38), an outwardly directed shoulder (39) into which opens the inlet (40) and which shoulder forms a valve seat for a valve body (41) the opposite-end abutment of which (45) is formed by the annular end of a fitting (43), and that the inlet is formed by bores (50—53) extending parallel of the valve housing axis, the bores being spaced about a circle within the shoulder (39) and communicate with the ambient air by radial bores (54—56) in the wall of the valve housing.

6. An internal combustion engine as defined in any of the preceding Claims 1—5, characterized in that a conduit (80) with a throttle valve (81) is connected to the intake conduit (11) and a point closely upstream of the inlet port, and that the throttle valve (81) is actuatable in dependence upon the position of the accelerator pedal.

7. An internal combustion engine as defined in Claim 1 wherein the ignition device consists of a spark plug, characterized in that feed channels (123, 124, 137) for feeding a flowable fluid into the working space of a cylinder of the engine are arranged directly at the spark plug (93), that at least one valve assembly (117—119; 120—122; 132, 140, 146, 148, 149) is provided in connection with these feed conduits, and that the valve assembly (120) comprises a check valve (149).

8. An internal combustion engine as defined in Claim 7, characterized in that at least one axially downwardly extending groove (123, 124) is provided on the mounting thread (91, 92), and the mounting thread (92) of the spark plug (93) includes a feed assembly (102) communicating with the at least one axially downwardly extending groove by an annular channel (110, 126).

9. An internal combustion engine as defined in Claim 8, characterized in that the at least one axially downwardly extending groove (123, 124) is arranged on the mounting thread (92) of the spark plug (93), and the annular channel is formed by an annular groove (110) in the region of the mounting thread (92).

10. An internal combustion engine as defined in Claim 8, characterized in that the feed assembly (102) consists of a nut member adapted to be threadedly engaged on the mounting thread, the nut member includes passages (106—108) opening toward the outside and toward the annular channel (110), the passages respectively defining valve seats (117—119), and a movable valve member (120—122) is disposed within an inner enlarged portion (111—113) of the passages.

11. An internal combustion engine as defined in Claim 2, characterized in that the feed assembly consists of an annular adapter (125) for the mounting thread (92), the adapter being retained intermediate gaskets (104, 105) on the mounting thread (92), and that the annular channel (126) is conncted by a feed conduit (130) with a check valve (132) the valve seat (135) of which is disposed on a valve chamber wall remote from the connection to the annular channel (126).

12. An internal combustion engine as defined in Claim 7, characterized in that the feed channel (137) extends centrally through the spark plug (93) and includes, at its exit end in the region of the center electrode (138), a check valve (140, 149) adapted to close in the direction of the terminal end of the spark plug (93), and that the center electrode (138) is tubular and includes, at its end adjacent the ground electrode, an enlarged portion serving as a valve chamber (139) for a check valve body (140) whereby the end facing the ground electrode (141, 142) is arranged as a permeable cage and a valve seat is provided at the inner end of the valve chamber.

13. An internal combustion engine as defined in Claim 7, characterized in that the feed channel (137) extends centrally through the spark plug (93) and includes, at its exit end in the region of the center electrode (138), a check valve (140, 149) adapted to close in the direction of the terminal end of the spark plug (93); and that the center electrode (138) is tubular and includes, at its inner end, a valve seat (148) for a valve body (149) which is provided on a shaft guided by at least a tubular portion of the center electrode (138), and that there is provided a spring (153) for biasing the shaft so as to urge the valve body (149) against the valve seat (148), that the shaft extends through the spark plug and mounts at its projecting end (154) a spring cap (155), a spring being arranged intermediate the spring cap and the upper end of the spark plug (93), and the spring cap (155) is guided at the tubular center electrode (138) which includes apertures open toward the outside for a fluid inlet below the spring cap (155).

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